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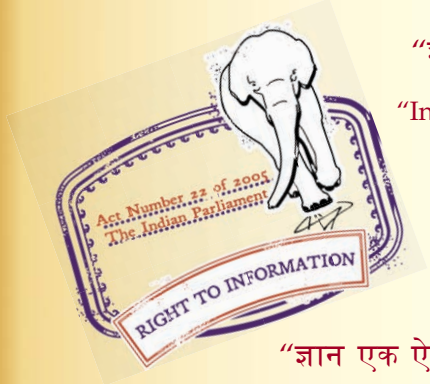
IS 11826 (1986): Recommended practice for chemical colouring for engineering components in general and for bicycle components [MTD 24: Corrosion Protection]



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Indian Standard

RECOMMENDED PRACTICE FOR CHEMICAL COLOURING FOR ENGINEERING COMPONENTS IN GENERAL AND FOR BICYCLE COMPONENTS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

RECOMMENDED PRACTICE FOR CHEMICAL COLOURING FOR ENGINEERING COMPONENTS IN GENERAL AND FOR BICYCLE COMPONENTS

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Indian Standard

RECOMMENDED PRACTICE FOR CHEMICAL COLOURING FOR ENGINEERING COMPONENTS IN GENERAL AND FOR BICYCLE COMPONENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 August 1986, after the draft finalized by the Metallic and Non-Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 A variety of shades and colours may be applied to metals by heat treatment, chemical colouring, electrolytic processes, etc. The term 'chemical colouring' of metal may be extended to include a great many other processes, many of which have been developed for quite different purposes — oxidizing, phosphating, chromating, etc. In this standard, emphasis has been laid on chemical dip only, excluding electrolytic deposition, electrolytic conversion, metallic laquites, vitreous enamelling, vacuum metallizing, anodizing and dyeing, organic coating, etc. Although a large number of formulations for colouring of metals exist in literature, attempt has been made to include the more common finishes which have commercial application.

0.3 Chemical colouring is generally performed on a metal surface which has been either polished or satin finished. It is carried out by dipping the component into a tank of the chemical solution and slowly moving it up and down for a few seconds of immersion. Colour matching is far from easy to achieve because the article, when immersed in solution, looks very much different from the rinsed, brushed, dried, possibly buffed and lacquered product. The colouring also depends on the basis metal. Alloys will produce different shades/lines. The pretreatment operations/processes and post colouring processes have not been included in this standard.

0.4 In laying down this standard, due weightage has been given to international co-ordination among standards and practices prevailing in different countries in addition to relating it to the practices in this country.

0.4.1 In the preparation of this standard, assistance has been derived from the following publications:

a) Metal colouring — David Fishlook Robert Draper Ltd, Teddington, U.K. 1962.

b) Metal finishing guide book and directory issue, 1982, Metals and Plastics Publications Inc. University Plaza, Hackensack NJ 07601, U.S.A.

1. SCOPE

1.1 This recommended practice is intended as an aid in establishing and maintaining a procedure for chemical colouring of metallic fabricated components used in engineering industries from steel, copper, brass, zinc, cadmium, aluminium, etc.

1.2 Metal colouring processes are employed mainly for decorative purposes. Sometimes the colour produced has a functional purpose like identification, corrosion resistance, etc.

1.2.1 Chemical colouring of metals is the process of imparting a desired colour to the surface of the metals by chemical means for achieving either one or all of the characteristics mentioned under **1.2**.

1.2.2 Chemical colouring may be applied to a wide range of metals and its alloys and also to articles electroplated. The electrodeposit shall be of sufficient thickness to withstand the action of the colouring chemicals applied.

2. TERMINOLOGY

2.0 For the purposes of this standard, the following definitions shall apply.

2.1 Surface — Surface on which colouring of metal is to be made.

2.2 Significant Surface — The surface agreed upon between the purchaser and the metal colour processor and indicated on the drawing or suitably marked on a sample with particular reference to the surfaces not to be coloured.

NOTE — Metal colouring does not involve any change in dimension of the components. Holes, recesses, bases of angles and similar inaccessible areas, are normally exempted from the requirements for significant surfaces, unless they are specifically designated as such.

3. CLASSIFICATION

3.1 Chemical colouring shall be classified as:

a) *Class A* — For decorative purposes where colour and uniformity of coating are of prime importance.

b) *Class B* — For decorative-cum-protective purposes such as on iron and steel, copper, zinc, cadmium, silver, etc.

4. MATERIALS AND WORKMANSHIP

4.1 Materials — The basis materials shall be such as to produce colour coating conforming to this standard.

4.1.1 The basis metal used for the classes of coating shall be substantially free from flaws or defects detrimental to the appearance or the protective value of the metal colouring.

4.2 Workmanship — All details of workmanship shall conform to the best practice of high quality metal colouring.

5. PRE- AND POST-COLOURING TREATMENT

5.1 Pre-colouring — It is necessary to clean the surface chemically to secure good adhesion of the colour deposit. Iron, steel, copper, brass, zinc, cadmium, aluminium, etc, surfaces generally necessitate pre-colouring treatements of degreasing, pickling and other metal cleaning processes to ensure good, clean surface to receive colouring and to yield a coloured surface as specified in this standard.

5.2 The elapsed time between the end of the cleaning process and the beginning of the colouring process shall be kept a minimum, otherwise the adhesion and brightness of subsequently coloured coatings may be affected. All residues of cleaning material shall be removed before colouring.

5.3 Post-Colouring — After thorough rinsing, a number of operations are adopted on the coloured metal surface such as scratch brushing, lacquering, oiling, etc. Even in lacquering, a variety of them are used like air drying cellulose type synthetic lacquers, gum lacquers, tinted lacquers, brushing lacquers, stoving lacquers, etc. The choice is left to an agreement between the processor and the purchaser.

6. CHEMICAL COLOURING

6.1 The colouring process shall be carried out as given in Appendix A appropriate for the basis metal; proprietary materials are also available for this purpose and should be used in accordance with the supplier's instructions.

6.2 Quality of Chemical Colouring — The metal colouring or chemical metal colouring shall appear as a smooth uniform in colour, continuous envelope over the basis metal and shall be free from blisters, pores and other visible defects that affect appearance or adhesion of the coloured layer to the basis metal surface.

6.3 Colour of Coating — Several factors play a significant part in the final finish of the colour. The most important are the aesthetic considerations involved, which apply to almost the same extent whether this article be a domestic ornament or an engineering component. So far there has been very little attempt to correlate the colours produced to any standard shade though there are innumerable commercial nomenclatures or shades. Hence the colour of this metal coloured shall be subject to agreement between the metal colour processor and the purchaser. On articles where the contact mark is inevitable, its position shall be the subject of agreement between the supplier and the purchaser.

6.4 Relieving — After colouring, some of the coloured films may be removed to allow the original colour of the metal to show, usually called relieving; this operation is most often carried out on dark films in the region of highlights on the surface. In this way, the highlights, whether a motif or pattern or simply a prominent contour, are brought into relief, enhancing the shape of the article and the depth and degree of contrast of the finish. This, too, is a skilled operation where a blend of colour may be required between the coloured and the exposed metal.

6.5 Characteristics of Coloured Layer (Film) — The metal colouring process produces films which are very much thinner, about 1 μm, and there is no commercial means of measuring their thickness. Hence, the coloured metal may be adjudged by comparison with an agreed sample. However, a reproducible shade is difficult to achieve and a certain degree of variation in shade between components coloured with same batch is unavoidable.

6.6 Composition of Basis Material — The composition of the basis metal if required, shall be made available to the colour processor to help in devising suitable cleaning prior to metal colouring and post-colouring processes.

7. LACQUERING

7.1 A final layer of lacquer shall be given on brass plating as a protective finish.

7.2 Lacquer conforming to IS : 349-1981* or any other suitable lacquer which meets the requirements of **7.2.1** and **7.3.1** shall be used.

7.2.1 The lacquer shall be abrasion resistant and shall have no reaction with the immediate substrate, for example, brass plating.

7.3 Lacquering Process — Lacquering shall be achieved either by dipping or by spraying, the consistency of lacquer being adjusted to suit the requirements.

7.3.1 The lacquer, which shall be clear and transparent, or coloured shall dry quick and hard, without leaving pores or breaks on the plated surface. After lacquering, the surface of the articles shall be scratched by a finger nail. The scratched area shall not show any white mark.

8. INSPECTION

8.0 The following test shall be carried out after the post colouring treatment (*see* **5.3**).

8.1 Freedom from Defects — Coloured metal components shall be free from untreated patches, and flaky and uneven deposits, sometimes caused by sludge in the bath. They shall be free from scratches, pits and residues of the processing solution as it may initiate deterioration of the organic coating or premature corrosion.

8.1.1 Samples of the coloured components or with prior agreement, the test coloured panels that are processed simultaneously with the components shall comply with the requirements of tests as in **8.2** and **8.3**.

8.2 Visual Tests — Visual tests include, coloured metal finish, matching of colour and general appearance. In considering the appearance of coloured article, it is necessary to take into consideration the surface texture of the article, the colour of the film produced and the extent to which the colour will be relieved in order to reveal the colour of the underlying metal.

8.2.1 To achieve uniform results, constant and standard condition for all tests shall be employed. The influence of illuminations is very much pronounced on colour matching. A non-glare 'daylight' type lighting like tubular fluorescent lamp is most satisfactory.

*Specification for lacquer, cellulose nitrate, clear, finishing, glossy for metal (*first revision*).

8.3 Adhesion Test — Place the sample in a bend tester with 4 mm radius of bending or in a vice as shown in Fig. 1. Bend the sample as far as 90° forward and backward, successive bends being made in opposite directions. For the purpose of this test, one bend shall constitute bending forward to 90° and back to original position. Repeat this process and count the number of bends until flaking occurs. The sample shall stand five such bends without flaking.

8.4 Corrosion Test — Coloured components or sample panels shall be subjected to neutral salt spray test specified in IS : 9844-1981*. The colour shall not become patchy nor any sign of corrosion shall occur within 24 hours. Slight staining or water mark may be allowed.

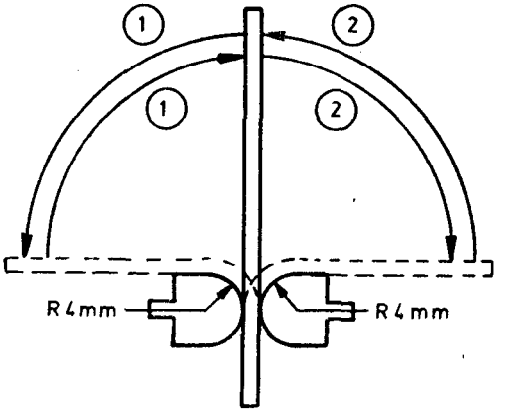

FIG. 1 BEND TESTER

8.5 Abrasion Test — Abrasion test of a coloured coating by rubbing the surface with a soft white tissue paper or with a gritless gum eraser, using normal hand pressure (about 10 strokes). There shall be no appreciable staining on the tissue paper when this is used for the test nor shall the colour coating be removed or worn through to the basis metal when rubbed with the paper or eraser.

9. SAMPLING

9.1 Sampling for Production Control — Statistical quality control is recommended for controlling the quality of chemical colouring of components. For this purpose, it is recommended that the articles that are coloured shall be taken from a place in the bath which is likely to give light shade and subjected to the test specified in **8.2**, **8.3**, **8.4** and **8.5**.

*Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by natural salt spray test.

9.2 Sampling for Acceptance of a Lot — For the purpose of this sampling, a lot shall be divided into sub-lots consisting of 100 articles or part thereof of any such articles, as are coloured at one time in the same bath. Two samples shall be selected from each sub-lot and subjected to the tests specified in **8.2, 8.3, 8.4** and **8.5**.

9.3 Criteria of Acceptance — If these samples pass the tests, the sub-lot represented by them shall be accepted. If one or both the samples should fail, two further samples shall be selected from the same sub-lot and subjected to the tests. If both these samples pass the tests, the sub-lot shall be considered as conforming to the standard. If either of them fails in any of the tests, the sub-lot shall be rejected.

10. MARKING

10.1 Coloured articles may also be marked with the name or the trademark of the processor.

10.1.1 Articles may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

APPENDIX A

(*Clause* 6.1)

CHEMICAL COLOURING FOR ENGINEERING COMPONENTS

A-1. PRE-COLOURING TREATMENT

A-1.1 Before colouring, the articles shall be perfectly cleaned as indicated in **5.1** to avoid patchy or discontinuity of the coloured film.

A-1.2 The composition of colouring baths indicated are typical ones and are for guidance. Processors are free to use either their own or proprietory colouring baths to suit the colour requested by the purchaser.

A-2. COLOURING OF STEEL

A-2.1 Black or Blue-Black on Steel

A-2.1.1 *Mild and Alloy Steels*

a) *Black oxide coatings*

Composition of Bath

Caustic soda	1200 to 1500 g/l
Sodium nitrate	30 g/l
Water	1 litre

Before use, the bath shall be brought to boiling (140 to 150°C) gently which aids the uniformity of the coating. Cleaned work requires an immersion time of 5 to 30 minutes until an acceptable colour develops, depending on the composition and homogeneity of the metal. Alloys which do not respond to this kind of treatment shall be given a dip in 5 to 10% solution of hydrofluoric acid. Since this strongly alkaline colouring solution is hazardous, the process must be applied with care, the maintenance of the proper water ratio being an important factor.

NOTE — On removal from the bath, the articles are swirled in warm, then in cold water, and finally in clean boiling water. To remove residual blackening salt, adhering to the components, it is essential to dip in a weak and hot chromic acid solution made as follows:

Chromic acid (conforming to IS : 330-1968*)	0·6 g
Water	1 litre
Temperature	65 - 80°C
*p*H	2 - 3

After immerion for about 2 minutes, the articles are dipped in boiling water and dried with dry compressed air.

b) *Manganese phosphate coating* — Phosphate coating on iron and steel vary in colour from pale grey to dark grey. The thicker and more absorbent coatings produced by some of the phosphating processes can be coloured by the absorption of dyestuffs. Since the coatings are porous, it is necessary to increase their durability by applying a coat of rust preventive oil. This process is mainly for industrial and military application identification. Blue colours are generally applied on screws for gauges, car distributed springs, etc.

*Specification for chromium trioxide (*first revision*).

A-2.1.2 *Chromium Steels*

Composition of Molten Salt Bath

Sodium cyanide	45 percent
Sodium bicarbonate	35 percent
Sodium chloride	20 percent

The temperature of the bath should be kept well above the melting point of the mixture and the object must be immersed for 2 to 3 minutes. On withdrawing, the piece must be rinsed carefully and dried.

A-2.2 Blue on Steel

Composition of Molten Salt Bath

Sodium nitrate	49 percent
Potassium nitrate	49 percent
Manganese dioxide	2 percent

The treatment requires the immersion of the well dried article into the molten bath kept at a temperature of 300 to 350°C for a few seconds. After withdrawal from the bath, the article is washed carefully first with cold water, then with boiling water and finally dipped in hot oil. If the temperature of the bath is raised to above 540°C, a dark blue colour may be obtained. In such an event, the length of the treatment must be reduced to avoid streakiness.

A-3. COLOURING OF COPPER

A-3.0 Copper is metal which can be coloured easily. The colour can be changed, depth varied and different shades obtained with case as the metal is quite reactive.

A-3.1 Bronze Effect — Two processes are generally used:

a) *Composition of Bath*

Copper sulphate	50 g/l
Ammonium chloride	25 g/l
Water	1 litre

The bath may be used at room temperature or at higher temperatures. The crystalline effect may be enhanced by subsequent immersion in a sulphide solution.

b) *Composition of Bath*

Solution No. 1 — Polysulphide	3·15 g/l
Solution No. 2 — Copper sulphate	10 g/l

After scouring the surface, the object is first immersed in solution No. 1. Then without rinsing, it is dipped in solution No. 2. Then it is rinsed in water and the cycle is repeated until the right colour is obtained. The article may be scratch brushed, when dry to get a uniform colour. To obtain a higher tone, the article may be dipped in solution No. 1 and to get a darker shade in solution No. 2.

A-3.2 Brown

Composition of Bath

Copper nitrate	30·0 g/l
Potassium permanganate	2·5 g/l
Water	1·0 litre

The bath is kept at 80°C and the article immersed for a few minutes depending on the depth of shade required.

A-3.3 Black

Composition of Bath

Potassium sulphide	15 g/l
Water	1 litre

Scour the surface of the article and immerse in hot lye for cleaning, rinse in water, treat with a cyanide solution (about 10 to 15%), rinse again and then introduce the article in the above bath at 35 to 38°C for about 5 to 10 seconds. Following the immersion, rinse in hot and cold water and dry in hot air.

A-4. COLOURING OF BRASS

A-4.1 Deep Black

Composition of Bath

a) Caustic soda	60·0 g/l
Water to make up	1 litre
b) Caustic soda	60·0 g/l
Potassium persulphate	7·5 g/l
Water to make up	1 litre

After cleaning, the brass article is immersed for a few minutes in the solution (a), firstly hot, then it is transferred to the second solution (b), nearly boiling hot for about 10 minutes. The material is mixed in running cold water followed by a rinse in hot water. To secure a smooth surface, it is recommended to rub the final coloured surface with a soft tissue.

A-4.2 Brilliant Black

Composition of Bath

White arsenic (arsenic trioxide)	240 g/l
Antimony chloride	150 g/l
Hydrochloric acid	1 litre

The solution is used hot without the addition of any water. This process is versatile in that most copper alloys are amenable for treatment. The depth of black can be intensified by wet scratch brushing and then re-immersing in the bath.

A-4.3 Blue-Black

Composition of Bath

Copper carbonate	160 g/l
Ammonia (r.d. 0·9)	330 g/l
Water to make up	1 litre

It is essential that an excess of copper salt should be present in the solution. The solution is heated to 80 to 90°C and the material immersed for about 10 seconds. After rinsing in running water, the metal is immersed in a weak alkaline solution (about 5 percent sodium hydroxide) and then rinsed well in water.

A-4.4 Steel Grey

Composition of Bath

Antimony trioxide	30 g/l
Hdyrochloric acid (r.d. 1·2)	64 g/l
Sulphuric acid (r.d. 1·84)	15 g/l
Water to make up	1 litre

The article is first immersed for about 5 to 10 seconds in the above solution at room temperature, rinsed in cold water first and then in hot water and force dried at about 90°C.

A-4.5 Blue

Composition of Bath

Sodium hyposulphite	60 g/l
Lead acetate	10 to 50 g/l
Acetic acid	30 g/l
Water to make up	1 litre

The bath is heated to 80°C and the article immersed for about 30 seconds.

A-5. COLOURING OF ZINC

A-5.1 Black

Composition of Bath

Potassium chlorate	50 g/l
Copper nitrate	50 g/l
Water to make up	1 litre

Prior to the colouring treatment, the surfaces should be cleaned and rubbed down with hot saw dust (oil-free). Then the black finish may be produced by dabbing the surface with a cloth moistened with the above solution.

A-5.2 Steel Blue

Composition of Bath

Cobalt chloride	60 g/l
Ammonium chloride	60 g/l
Water to make up	1 litre

The bath is heated to 60°C and the cleaned articles is immersed for about 3 to 5 minutes and rinsed in cold water.

A-5.3 Brown

Composition of Bath

Copper nitrate	200 g/l
Water to make up	1 litre

The article to be coloured is cleaned and immersed in the above bath for a short period. Final rinsing in hot water may be beneficial.

A-5.4 Yellow to Brown — Dichromate based solutions occupy a unique position among colouring of zinc because of their passivating properties. They are used at room temperature. Chromate solutions are capable of yielding a rich variety of pleasing and lasting colourations on zinc.

Composition of Bath

Sodium dichromate	2 g/l
Sulphuric acid	6 to 9 ml/l
Water to make up	1 litre

Processing is carried out at room temperature. Yellow to dark brown tints can be obtained depending on length of immersion and 'age' of the bath.

A-6. COLOURING OF CADMIUM

A-6.1 Deep Black or Near Black

Composition of Bath

Copper sulphate	15 g/l
Potassium chlorate	20 g/l
Sodium chlorate	20 g/l
Water to make np	1 litre

The solution should be kept at a working temperature of 85 to 90°C and agitated. The cleaned article should be immersed in the hot solution for a few seconds. According to the conditions, either a deep black or a near black coating of cupric oxide will be deposited on the cadmium surface.

A-6.2 Black or Antique Silver

Composition of Bath

Potassium chlorate	6 g/l
Copper sulphate	25 to 35 g/l
Water to make up	1 litre

The above bath will impart a colouration ranging from black to antique silver shade to cadmium depending on the duration of immersion and concentration.

A-6.3 Yellow or Mahogany

Composition of Bath

Potassium dichromate	6·25 g/l
Nitric acid	1·5 ml
Water to make up	1 litre

The bath will yield tint ranging from yellow to mahogany to cadmium by immersion for 2 to 4 minutes. Darker shades could be produced by extending the immersion time to 6 to 8 minutes and keeping the bath between 60 and 65°C. Scratch brushing will make the colouring more uniform and polishing with tripoli sand is also recommended after drying.

A-7. COLOURING OF ALUMINIUM

A-7.1 Light to Dark Grey

Composition of Bath

Sodium carbonate	20 to 25 g/l
Sodium dichromate	5 to 25 g/l
Water to make up	1 litre

The above formula will yield tint varying from light grey, on pure aluminium, to dark grey on alloys containing more silicon. The colour can be further improved by immersing the object into a solution (5 g/l) of potassium permanganate.

The process is best carried out at room temperature. However, a warm bath at about 60 to 65°C may be beneficial.

A-7.2 Black

Composition of Bath

Potassium permanganate	10 g/l
Cobalt nitrate	25 g/l
Nitric acid	4 ml
Water to make up	1 litre

The process is best carried out at about 20°C. Intermittent scratch brushing will improve the colour and adhesion.